A STUDY ON MOTOR CONTROL IN PRETERM NEONATES UTILIZING A NEURODEVELOPMENTAL TREATMENT PROTOCOL

''बेटी बचाओ, बेटी पढाओ''

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Jayoti Vidyapeeth Women's University

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Supervised by:
JVN's Prof (Dr). Ankit Bhargav

Submitted by:
JVN's Vidhi Singh
JVR-I/22/10055

FACULTY OF PHYSIOTHERAPY & DIAGNOSTICS
JAYOTI VIDYAPEETH WOMEN'S UNIVERSITY
JAIPUR (RAJASTHAN), INDIA

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1. INTRODUCTION

Preterm birth in humans refers to birth before the whole gestational period (37 weeks); a baby is considered "premature" if its development has not yet reached the point at which it is usually possible for it to live outside the womb. In a typical human pregnancy, several organ systems develop between 34 and 37 weeks, and by the conclusion of this time, the foetus has reached appropriate maturity.

One of the most significant issues of the modern era is preterm birth. Due to their motor, cognitive, and sensory deficiencies, preterm newborns have a decreased survival rate [1-3].

There is an increased risk of cerebral palsy due to prematurity is well documented. Recent studies highlight the range and severity of cognitive, sensory, language, visual-perceptual, attention and learning deficits in very preterm children. The neuroimaging studies also help to identify perinatal risk factors. Hence neurodevelopmental follow-up of neonatal intensive care unit trials offers the potential to really improve our understanding of how the preterm brain develops, is injured and recovers from injuries. A better knowledge / understanding of what influences the neurodevelopment outcomes is the main key for developing better treatment strategies [4-7]

MOTOR PERFORMANCE IN PREMATURE INFANTS:

Usually the infant uses movement to communicate and interacts physically with objects or people by changing postures, entertaining movements in response to environmental demands and for self – comforting. Hence the infants usually exhibit normal active movement which is necessary for optimal perceptual development which lags in infants born prematurely [8-10].

Hence the children, born prematurely exhibit lower motor performance scores than infants born at term. Those infant's central nervous system defects have more chance of developing poor motor outcome [11-12]. The incidence of cerebral palsy is 25 to 30 times higher in infants with birth weight less than 1500g [13-14].

The purpose of this study was to assess the efficacy of Neuro- Developmental treatment administered for infants born less than 35 weeks of gestational age which shows aberrant motor development.

NEURO-DEVELOPMENTAL THERAPY

Neurodevelopmental treatment (NDT) is widely used by clinicians when working with children diagnosed with neurological dysfunction, such as cerebral palsy, high-risk/low-birth weight infants or traumatic brain injury [15-17].

In Neurodevelopmental Treatment (NDT), postural control is the basic foundation on which the babies begin to develop their skills. Patients undergoing this treatment which eventually learn how to control postures and movements and then progress to more difficult ones. Therapists will analyse certain postures and movements and look for any abnormalities during testing, such as common abnormal movement patterns that include obligatory synergy patterns [18-20]. These patterns can be described as the process of learning an isolated movement of a particular limb, but triggering the use of other uninvolved muscles in order to achieve movement. Preterm infants seem to benefit most from intervention that aims at mimicking the intrauterine environment, such as NIDCAP intervention. After term age, intervention by means of specific or general developmental programmes has a positive effect on motor development [21-25].

2. REVIEW OF LITERATURE

The review of literature is defined as a broad, comprehensive in depth, systematic and critical review of scholarly publications, unpublished scholarly print materials, audio visual materials and personal communications.

The reviewed literature provides the evidence of what has been studied in the past and published; paying way for further study in the chosen subject. It justifies the need for study; throws light on the feasibility of the study, reveals methodology and relates the findings from one another with a hope to establish a comprehensive study of scientific knowledge.

1. **Martha C. Piper, V. Ildiko Kunos, Diana M. Willis, Barbara L. Mazer** states that early physical therapy program investigated in this study was efficacious in altering the pattern of motor development in those high-risk infants participating in the trial.1986 by the American Academy of Paediatrics.

2. **Brown G.T.; Burns S.A.** confirmed studies that included the use of NDT with high-risk/low-birth weight infants did support the usefulness of NDT with this paediatric client group. The British Journal of Occupational Therapy, Volume 64, Number 5, 1 May 2001, pp. 235-244(10).

3. **Campbell SK, Siegel E, Parr CA, et al** suggest that early intervention program such as Neuro-Developmental treatment therapy helps in improving the motor and postural control in pre-term infants. JAMA. 2009;63: 305-310.

4. **Lekskulchai R, Cole J** suggest that the NDT intervention program is likely to have beneficial effects when offered to a similar population of preterm born infants. Aust J Physiother.2001; 47(3):169-76.

5. **Maria Ramsay, Kenneth M. Silver** suggest that physical therapy intervention provides more beneficence to improve tone in pre-term infants. American Academy of Paediatrics; November 21, 2009.

6. **Als H, Lawhon G, Duffy FH, McAnulty GB, Gibes- Grossman R, Blickman JG.** Confirms that Very low-birthweight preterm infants may benefit from individualized developmental care in the neonatal intensive care unit in terms of medical and neurodevelopmental outcome. JAMA. 1994 Sep 21; 272(11):853-8.

7. **Cornill H Blauw-Hospers MSc, Mijna Hadders-Algra MD PhD** states that Preterm infants seem to benefit most from intervention that aims at mimicking the intrauterine environment, such as NIDCAP intervention. After term age, intervention by means of specific or general developmental programmes has a positive effect on motor development. Developmental Medicine & Child Neurology13 FEB 2007.

8. **Muriel Goodman, AlanD. Rothberg, JoyceE. Houston- Mcmillan** states that high-risk infants had higher mean neurodevelopmental scores throughout the study period and lower 1-year development quotients (DQ) than normals. In at risk groups did neurodevelopmental therapy alter the pattern of development or the outcome. Department of Physiotherapy and Paediatrics, University of the Witwatersrand, Johannesburg Hospital, United Kingdom., 24 September 2003.

9. **Betty R. Vohr, MD, Linda L. Wright, MD, Anna M. Dusick, MD, Lisa Mele, MS, Joel Verter, PhD** states that early low birth weight infants are at significant risk of neurologic abnormalities, developmental delays, and functional delays, thus having poor motor control and Neurodevelopmental delay. 2000 American Academy of Paediatrics 141:1188-1193

10. **Lucas A, Morley R, Cole TJ** states that there was adverse neurodevelopmental outcome of preterm neonatal motor control, thus decrease movements and may lead to delayed growth. BMJ. 1998; 297:1304-1308.

11. **Bratzelon K.,** states that neonatal behavioural assessment scale is a valuable measure for assessing neonatal behaviour.1999;

12. **Heidelise Als, PhD; Gretchen Lawhon, RN, PhD; Frank H. Duffy, MD** concludes that Very low-birth-weight preterm infants may benefit from individualized developmental care in the neonatal intensive care unit in terms of medical and neurodevelopmental outcome. JAMA. 2004;272: 853-858;

13. **Hawthorne, J. (2005)** states that the Neonatal Behavioural Assessment Scale to support parent-infant relationships Infant and is also used to measure the behavioural pattern of the infant 213-18.

14. **Richard A. Ehrenkranz, MDa, Anna M. Dusick, MD** states that analyses suggest that growth velocity during an ELBW infant's NICU hospitalization exerts a significant, and possibly independent, effect on neurodevelopmental and growth outcomes at 18 to 22 months' corrected age.2006 by the American Academy of Paediatrics.

15. **Mandy B. Belfort, MD, MPHa, Sheryl L. Rifas-Shiman, MPHb, Thomas Sullivan, BMa, Comp Scc, Carmel T. Collins, RN, BSSc, PhD** studied on the Neurodevelopment of the preterm infant and after term states that in preterm infants there was an increased weight gain but not proportionate to length which was due to the developmental improvement in NICU stay. 2011 by the American Academy of Paediatrics.

16. **Dubowitz L, Dubowitz V.** states that the Supplemental Motor Test is a reliable measure for measuring the motor control of preterm infants. 2004.

17. **Girolami GL.,** States that the Neuro-Developmental treatment therapy helps improving the motor control in patients. 2007 University of North California.

18. **Paludetto LG, Watkins MP** states that there is an early behavioural development in preterm infants. Dev Child Neuro 1999;26: 347-353.

19. Stroke results most commonly from arthereothrombic brain infarction, cerebral embolus or hemorrhage **(U.S. Department of Health and Human Services, 1995)**. This brain damage leads to numerous neurologic impairments which vary in extent from client to client. Over 75% of clients have sensorimotor impairments which affect motor control necessary for functional skills (U.S. Department of Health and Human Services, 1995). As a result of these sensorimotor impairments along with other neurological impairments, stroke clients have a variety of functional disabilities. The focus of rehabilitation is the remediation of underlying impairments as well as teaching strategies to maximize functional abilities.

20. Motor control impairments are evident in several prerequisites to movement such as strength, tone and movement selectivity. Loss in muscle strength is the most overt movement impairment in stroke clients **(Bohannon, 1988; Bohannon, 1992).** This strength deficit, known as hemiparesis, is present in three quarters of the stroke population and is frequently the target of therapeutic intervention (Bohannon, 1992; U.S. Department of Health and Human Services, 1995). Although hemiparesis is typically most evident on the side of the body opposite the brain lesion, this impairment is often seen in all four extremities as well as the trunk (Bohannon, 1988; Bohannon, 1992; U.S. Department of Health and Human Services, 1995).

21. Upper extremity strength loss has been objectively reported by lowered electromyographic (EMG) values in the hemiplegic arm **(Gowland, deBruin, Basmajian, Plews & Burcea, 1992).** Clients demonstrate an inability to recruit fast twitch motor units which are necessary to generate force at high velocities of movement (Harro, 1985).

22. There is also an atrophy of fast twitch muscle fibers which results in a decreased amount of fimctioning motor units **(McComas, Rica, Upton & Aquileva, 1973).** This limited recruitment results in a decreased ability to generate adequate strength to perform motor tasks (Gowland et al., 1992). In addition, there are also alterations in the timing of agonist and antagonist muscle recruitment.

23. **According to Gowland et al. (1992)** an inadequate recruitment of agonist muscles in the affected upper extremity results in a decreased ability to carry out movement tasks. These changes in motor unit activation and muscle fibers contribute to the dynamic strength deficits observed in stroke clients (McComas et al., 1973). Although the above research was completed on upper extremities, trunk strength is also compromised as a result of stroke (Boharmon, 1988; Bohannon, 1992; Davies, 1990, p. 31).

24. **According to Davies (1991),** there are several reasons for the loss of trunk strength and movement selectivity. First, since both sides of the abdominal muscles attach to the linea alba through the central aponeurosis, efficient muscular action is dependent on both sides

working together. If the aponeurosis does not provide for a stable insertion, the abdominal muscles on the noninvolved side are effected as well. Since the involved musculature has a decreased ability to generate force, and cannot counteract pulling forces of the noninvolved muscles, the end result is ineffective abdominal muscle action. Second, abdominal muscle strength is further disadvantaged in the abnormal sitting posture common to a stroke client. The individual often sits with a rounded spine and posteriorly rotated pelvis. This position places the muscles in a shortened position and prevents effective activation. These strength impairments are observed functionally in sitting. The sitting posture assumed by the stroke client is not due to weak extensors, but rather to lack of abdominal strength.

25. **Davies (1990)** posed that since the abdominal muscles are ineffective and trunk extensors lack a counterbalance, compensatory posture is assumed (Davies, 1990, pp. 33-34,48). Tonal changes occurring due to stroke can also limit function **(Bobath, 1990, p. 11; Carr & Shepherd, 1983, pp. 35-36; Davies, 1994, p. 7).**

26. Stroke causes alterations in neural and nonneural intrinsic properties of muscle fibers, which may lead to hypertonia or hypotonia **(Shumway-Cook & Woollacott, 1995, p. 402).**

27. **Sahrmann and Norton (1977)** reported that an inappropriate activation of the stretch reflex will result in an increase in muscle tone. This can be seen in the upper extremities as well as in the trunk.

28. Following stroke, the client with increased tone may posture the involved upper extremity in an abnormal synergy pattern, and develop trunk leans in response to the pulling effect of the spastic musculature **(Davies, 1990, p. 4; Crutchfield, 1989, p. 236).**

29. Similar to the client with increased tone, the hypotonic individual may also demonstrate comparable losses. Restriction of movement, be it due to tonal abnormalities or weakness, can impede rehabilitation and may limits the client's potential for recovery **(U.S. Department of Health and Human Services, 1995).**

30. Difficulty with movement selectivity is also observed following stroke. Stereotyped mass movement patterns in which the muscle response is the same for every effort, regardless of task demand, is a common deficit for the stroke client **(Davies, 1994, pp. 24-29; Duncan & Badke, 1987, pp. 150-151; Perry, 1969)**. The client may not demonstrate muscle weakness, but may have apraxias of movement (U.S. Department of Health and Human Services, 1995).

31. Function of the upper extremity requires selective and fine motor control; compensation for lack of control is difficult (Duncan, Goldstein, Matcher, Divine, & Feussner, 1994). Therefore, deficits in movement selectivity can affect the individual's ability to successfully and efficiently perform activities of daily living. Sensory deficits also influence abnormal motor control observed following stroke. Frequently, somatosensory

and visual deficits are present post stroke. These deficits can impair the control of complex multiarthrodial movements **(Duncan & Badke, 1987, p. 140)**.

32. **In a study performed by Jearmerad, Michel and Prablanc (1984)**, voluntary upper extremity movements were impaired as a result of sensory deficits. Subjects in this study, who had only sensory loss, displayed slowed motor control and were limited to simple monoarticular movements. They also demonstrated excessive cocontration of both agonist and antagonist muscle groups and had difficulty sustaining a muscle contraction. In addition to altered sensation impaired visual feedback, specifically homonymous hemianopsia, has been reported in numerous stroke samples (Post Stroke Rehabilitation, 1995).

33. **According to Wing and Frazer (1983)**, visual feedback concerning thumb and finger position are necessary to provide information regarding limb position during tasks. Sensory impairments therefore, can also contribute to functional deficits in stroke clients, especially upper extremity tasks.

34. **Jaberi E and Roksana M (2016),** conducted a retrospective study of hospital records of premature babies born in all the five governmental tertiary care settings during the time interval of 2013-2015 in Shiraz. The prevalence and health outcomes of preterm deliveries in tertiary care university hospitals were analysed. In conclusion, this study showed that premature births and its complications for newborn need to be addressed more in Iran.

35. **Myles P (2014),** conducted a study on preterm delivery and low birth weight (LBW) in Marathwada region of Maharashtra state. The data was collected on all in-hospital births in the maternity department of Halo Medical Foundation's hospital. Among the 655 live births 6.1% were preterm deliveries and 13.8% were LBW (<2.5 kilograms at birth). The preterm delivery were three times higher and the LBW were double among women <22 years of age compared with older women. The both preterm delivery and LBW were reduced in multigravida women compared with primi gravida women regardless of age. The study concluded that the preterm delivery and LBW were much higher in mothers below 22 years of age.

36. **Rahele Alijahan (2014),** conducted a case control study to determine prevalence and risk factors associated with preterm birth in Ardabil, Iran. All the live newborns during the study period were investigated. Of 6705 live births during the study period 346 births occurred in <37 weeks were taken as a case and 589 term neonates were taken as a control group. Data were obtained through review of prenatal and hospital delivery records. The study concluded that maternal illness and the health care quality delivered to pregnant women may reduce preterm prevalence rate.

37. **Wang (2013),** conducted a study to measure the incidence rates of preterm delivery in pregnant women and to explore related potential risk factors. Data was collected from 'Information System of Prevention of Mother-child Management in China. Information

regarding demographic characteristics, pregnancy, and pregnancy outcomes were extracted and analyzed. Results from univariate and multivariate analyses showed that preterm delivery was associated with factors as: maternal age, ethnicity, education, pregnancy induced hypertension, multiple pregnancy and times of antenatal care visits of the pregnant women.

38. **TMA Pai (2014),** conducted a case control study to identify the risk factors of preterm birth in a secondary care hospital in Southern India. The records of 153 antenatal women with preterm birth were included. Gestational age at delivery and associated risk factors were analyzed. The study concluded that the commonest obstetrical risk factor for preterm birth was hypertensive disorders of pregnancy and non-obstetrical risk factor was height 150c m. The percentage of preterm birth was low, comparable to developing countries.

39. **Talsania NJ (2011)** conducted a study to determine risk factors associated with preterm delivery, perinatal mortality, and neonatal morbidity in New Civil Hospital, Ahmedabad, India. The study concluded that scoring system used has a higher sensitivity to predicting preterm birth and perinatal mortality among high risk women, and poor sensitivity among low risk women. Moderate and mild risk could be identified with this system and referred for follow-up.

40. **Shivalinga Swamy (2005),** conducted a prospective study among 340 pregnant women between 18 and 28 years of age related to association of maternal periodontitis with preterm delivery and low birth weight in the state of Karnataka, India. Subjects filled out a questionnaire and underwent a periodontal examination during the second trimester of pregnancy. The study concluded that the results suggest that periodontitis is an independent risk factor for poor pregnancy outcome.

41. **Yu-xia Zhang et al. (2014),** conducted a study to evaluate the effect of an oral stimulation program on preterm infants. 72 preterm infants were randomly assigned to experimental and control groups. Controls (n = 36) received routine care while the experimental group (n = 36) received oral stimulation in addition to routine care. The study concluded that early oral stimulation program is beneficial in preterm infants.

42. **Zhang (2013),** conducted the study to evaluate the effectiveness of non-nutritive sucking and oral stimulation, either applied alone or in combination, to reduce the transition time from tube feeding to independent oral feeding. The researcher took 112 preterm infants assigned to three intervention group (non-nutritive sucking, oral stimulation, and combined non-nutritive sucking and oral stimulation). The result showed that the combined non-nutritive sucking and oral stimulation intervention reduced the transition time from introduction to independent oral feeding and enhanced the milk transfer rate.

3. AIM & OBJECTIVES OF THE STUDY

To find out the efficacy of a Neuro–Developmental Treatment program to improve motor control in pre-term infants.

Previous research demonstrated that in the Neonatal Intensive Care Unit, low levels of stimulation would result in positive neurobehavioral responses (NICU). According to several additional research, preterm newborns' weight gain is improved by posture and intensive nursing care. This study's objective is to assess the effectiveness of a neurodevelopmental treatment programe intended to enhance motor control in preterm infants who were at a high risk of developmental impairment.

4. STATEMENT OF THE PROBLEM

In addition to regular nursing care and positioning, preterm infants also have a delay in their motor development. Therefore, the purpose of the study is to ascertain HOW EFFECTIVE THE NEURODEVELOPMENTAL TREATMENT PROTOCOL IS AT IMPROVING MOTOR CONTROL IN PRETERM INFANTS.

5. MATERIALS AND METHODOLOGY

PARTICIPANTS

Thirty preterm infants were randomly assigned to receive Neuro-Developmental Treatment protocol two times per day for 7 days.

MATERIALS

- Cotton rolls
- Towel
- Data collection and recording sheet.

METHODOLOGY

a. STUDY DESIGN

This is a study with two groups. One received routine nursing care with positioning and other received Neuro-Development Treatment protocol. The results were compared.

b. STUDY SETTING

The study was carried out in NICU, Sri Ramakrishna hospital, Coimbatore.

c. SAMPLING TECHNIQUE

Convenient random sampling.

d. SAMPLE SIZE

100 pre-term infants were assigned into two groups of 15 each.

e. STUDY DURATION

The study was conducted for a period of 7-20 days.

f. SELECTION CRITERIA

Inclusion criteria

- Gestational age below 35 weeks
- Birth weight less than 1800 gm
- NICU stay for minimum 7 days
- Should evidence at least 3 of the following medical complications
- 5-minute Apgar score of 5 or less
- Intraventricular haemorrhage documented by ultrasound
- Central nervous system depression
- Asphyxia
- Birth weight less than 1000 gm.
- Respiratory arrest
- Respiratory distress syndrome
- Need for mechanical ventilation
- Thermal instability

Exclusion Criteria

- Genetic anomalies
- Congenital malformations
- Human - immuno deficiency virus.
- Hepatitis B
- Birth weight above 2000 gms

h. METHODS OF COLLECTION OF DATA

Subjects who fulfil the selection criteria will be selected for the study and informed consent will be obtained from their parents or guardian. All the subjects will be randomly divided into Group A (Control group) and Group B (Experimental group).

Group A (Control group) subjects will receive routine treatment which includes medications, nursing care and positioning. The positioning includes prone, side lying, supine and supported sitting positions to facilitate movement and active postures. Group B (Experimental group) subjects will receive the above mentioned routine treatment and additionally Neuro–Developmental Treatment program. The Neuro-Developmental treatment program was designed to influence the infant's ability to lift heads in prone, bring hands to mouth, hold the head in midline in supine position, and lift and hold the arms and lower extremities up against the force of gravity.

At no time during the study did treatment need to be discontinued because of tachycardia, bradycardia, increased or decreased respiratory rates, excessive crying or apnea. All the subjects will be treated in

study setting with two minutes session per day for 7 continuous days and the outcome will be assessed by using Neonatal Behavioural Assessment Scale & Supplemental Motor Test to know the effectiveness before and after 7 days of study.

i. OUTCOME MEASURES

- Neonatal Behavioural Assessment Scale
- Supplemental motor test.

j. Treatment duration

Two treatment sessions of 12-15 minutes period per day for 7-20 days.

6. RESEARCH HYPOTHESIS

Null hypothesis

'There is no significant improvement of motor control with Neuro–Developmental Treatment program in pre-term infants'.

7. REFERENCES

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